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THOMPSON, JAMES A	
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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

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Office Action Summary	Application No.	Applicant(s)	
	09/727,609	KEMPF, JEFFREY	
	Examiner	Art Unit	
	James A. Thompson	2625	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *16 April 2007*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☐ Claim(s) _____ is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-22* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *08 February 2005* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Response to Arguments

1. Applicant's arguments, see page 13, lines 7-28, filed 16 April 2007, with respect to the rejections under 35 USC §101 have been fully considered and are persuasive. The rejections under 35 USC §101 listed in items 2-3 of the previous office action, mailed 16 October 2007, have been withdrawn.

2. Applicant's arguments filed 16 April 2007 have been fully considered but they are not persuasive.

Regarding page 13, line 30 to end of page 15: Nguyen (USPN 5,892,851) does not explicitly teach away from the invention. Nguyen simply teaches a type of parallelism that is slightly different from the presently recited claims. The manner in which the error diffusion coefficients and filters are set in Nguyen are a product of the precise type of parallelism employed in Nguyen. This does not constitute a "teaching away", but is simply based on the slight differences between the parallelism schemes employed. For example, the cut filter must have zero weight for the pixel immediately to the right simply because the parallelism of Nguyen divides each line among the various processors operating in parallel with each other. Each processor processes the same portion of each line until the processing is completely finished. By using this scheme, the cut filter must have a zero weight for the pixel immediately to the right since the pixel immediately to the right would have already been processed first by another processor. Thus, the far left pixel of one segment could not use any error diffusion data from a pixel at the far right of a different segment (processed by a different processor). If the parallelism scheme of Nguyen is altered, then the requirements for error diffusion filters would also be altered. The requirements of the cut filter are explicit requirements of the system of Nguyen and must be followed *if the system of Nguyen is used without alteration*. If the system is modified, such as according to the teachings of Metaxas, then the requirements for the error diffusion filters would also naturally change according to the modified teachings.

Metaxas (USPN 6,307,978) provides a teaching which would improve upon the parallel scheme of Nguyen by providing a "staggering" arrangement (such as shown in figure 3 of Metaxas) which permits the error diffusion to be better diffused throughout the whole image, and also improves upon the speed of the parallel processing, both of which are clear advantages which would motivate one of ordinary skill in the art at the time of the invention to combine the teachings of Nguyen and Metaxas.

Regarding page 16, line 1 to end of page 17: Examiner was not suggesting that the pixel in a single segment corresponding to the filter labeled **100** was processed at the same time as the pixel in a single segment corresponding to the filter labeled **500**. Rather, simultaneous processing is performed upon one pixel in each segment that corresponds to a filter labeled **100** at each time, until the end of each segment is reached. At the end of each segment, each pixel corresponding to a filter labeled **500** is processed simultaneously.

A four-weight filter (figure 5(100) of Nguyen) is applied to all but the last one of the pixels in a segment of the image row (column 4, lines 6-7 of Nguyen) and a three-weight filter (figure 5(500) of Nguyen) is applied to the last pixel in said segment (column 4, lines 4-5 of Nguyen). Each segment of the image row is computed in parallel (column 3, lines 55-59 of Nguyen). The image rows (figure 5(510) of Nguyen) are processed one image row at a time (column 3, lines 18-19 of Nguyen), as demonstrated in the example embodiment in column 5, lines 35-40 of Nguyen. When a pixel in a segment is processed according to the filter labeled **100** in figure 5 of Nguyen, corresponding pixels in the other segments are also being processed according to the filter labeled **100** in figure 5 of Nguyen. When the end of each segment is reached, then each processor is processing a pixel in each segment corresponding to the cut filter labeled **500** in figure 5 of Nguyen. Furthermore, since the next image row is to be processed next, then the last pixel abuts the group of pixels to be processed next.

Finally, since the remaining claims are argued by Applicant based on either similar grounds or the dependency of dependent claims, the same reasons for maintaining rejections are also applied. Since the modifications made to the prior art rejections have been necessitated by the present amendments to the claims, the present action is made final.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. **Claim 1 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nguyen (US Patent 5,892,851) in view of Metaxas (US Patent 6,307,978 B1).**

Regarding claim 1: Nguyen discloses a method of performing error diffusion comprising the steps of:

- simultaneously processing image data for at least two pixels (figure 5(100,500(associated pixels)) of Nguyen) in a row of pixels (figure 5(510) of Nguyen), said at least two pixels comprising a first group of pixels (figure 5(100(associated pixels)) of Nguyen) and a last pixel (figure 5(500 (associated pixels)) of Nguyen) (column 4, lines 1-7 of Nguyen). A four-weight filter (figure 5(100) of Nguyen) is applied to all but the last one of the pixels in a segment of the image row (column 4, lines 6-7 of Nguyen) and a three-weight filter (figure 5(500) of Nguyen) is applied to the last pixel in said segment (column 4, lines 4-5 of Nguyen). Each segment of the image row is computed in parallel (column 3, lines 55-59 of Nguyen). The image rows (figure 5(510) of Nguyen) are processed one image row at a time (column 3, lines 18-19 of Nguyen), as demonstrated in the example embodiment in column 5, lines 35-40 of Nguyen. When a pixel in a segment is processed according to the filter labeled **100** in figure 5 of Nguyen, corresponding pixels in the other segments are also being processed according to the filter labeled **100** in figure 5 of Nguyen. When the end of each segment is reached, then each processor is processing a pixel in each segment corresponding to the cut filter labeled **500** in figure 5 of Nguyen. Furthermore, since the next image row is to be processed next, then the last pixel abuts the group of pixels to be processed next.
- reducing the precision of said image data to produce a modified image data word (column 3, lines 7-10 of Nguyen) and an error word for each pixel (column 3, lines 5-7 of Nguyen). Since the image is originally a continuous-tone image and is transformed into a halftone image (column 3, lines 7-10 of Nguyen), then the precision of said modified image data is reduced since a halftone image, by definition, comprises only one bit per pixel and a continuous-tone image, by definition, comprises more than one bit per pixel. Error diffusion processing of image data (column 3, lines 5-7 of Nguyen), by definition, produces an error word for each pixel based on the difference between the halftone value and the original continuous-tone value, and then diffuses said error to other pixels.
- propagating a portion of said error word for each pixel in said first group to at least two pixels in a next row of pixels (figure 5(100(associated pixels)); column 3, lines 21-25; and column 4, lines 6-7 of Nguyen). The four-weight filter (figure 5(100) of Nguyen) is used for all of the pixels of

the segment except for the last one (figure 5 and column 4, lines 6-7 of Nguyen). A portion of said error word for each pixel using said four-weight pixel (first group) is propagated to two pixels (figure 3(360,370) of Nguyen) in the next row of pixels, as demonstrated by the error diffusion arrows of figure 5(100) of Nguyen and the error diffusion propagation shown in figure 3 of Nguyen in which the error of pixel **100** is propagated to pixels **360** and **370**, which are clearly in the next row to be processed (column 3, lines 21-25 of Nguyen).

- propagating a first portion of said error word for said last pixel to at least one pixel in said next row of pixels and a second portion of said error word for said last pixel to at least one pixel in said group of pixels to be processed next (figure 5(500(associated pixels)) and column 4, lines 1-5 of Nguyen). Figure 6 of Nguyen shows the three-weight filter (column 2, lines 53-55 of Nguyen) used for the last pixel of each segment (column 4, lines 4-5 of Nguyen). Error is propagated from said last pixel into the next row using said three-weight filter (column 4, lines 1-5 of Nguyen). As can clearly be seen from figure 5 of Nguyen, the error portions corresponding to figure 6(630) and figure 6(620) of Nguyen (first portion) are each propagated to a pixel in said next row of pixels and the error portion corresponding to figure 6(610) of Nguyen (second portion) is propagated into the first pixel of the segment below and to the right of said last pixel. The segment below and to the right of said last pixel is to be processed next since all segments of a row are processed in parallel (column 3, lines 55-59 of Nguyen).
- outputting a data signal for causing a display corresponding to said at least two pixels in said next row of pixels at least in part in response to said first portion of said error word (figure 2(280) and column 3, lines 5-10 of Nguyen – *results of method output to an output device (display))*.
- outputting a data signal for causing a display corresponding to said at least one pixel in said group of pixels to be processed next at least in part in response to said second portion of said error word (figure 2(280) and column 3, lines 5-10 of Nguyen – *results of method output to an output device (display))*.

Nguyen does not disclose expressly that said group of pixels to be processed next, which are abutted by said last pixel, are in said row of pixels.

Metaxas discloses a group of pixels to be processed next which are abutted by the last pixel of the group of pixels that are being processed (figure 3; figure 5; and column 4, lines 48-55 of Metaxas). Error diffusion processing is performed in a diagonal manner (figure 5 and column 4, lines 48-55 of Metaxas). Furthermore, a pixel is only processed after all of the pixels from which said pixel depends have been processed. Thus (referring to figure 5 of Metaxas), the first pixel of the first row of A_{K-1} is processed only

after the last pixel of the first row of A_K is processed. Thus, the last pixel of the first group of pixels to be processed abuts the group of pixels to be processed next in said row of pixel.

Nguyen and Metaxas are combinable because they are from the same field of endeavor, namely parallel error diffusion. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to combine the parallel processing method taught by Nguyen with the parallel processing method taught by Metaxas. Thus combined, the individual area (such as A_K in figure 5 of Metaxas) would be processed according to the method of Nguyen while the overall image would be processed according to the method of Metaxas. Therefore, the length "d" in figure 5 of Metaxas would be broken into two or more sections to be processed in parallel, such as shown in figure 5 of Nguyen. When the last pixel of A_K in figure 5 of Metaxas is processed, the next group to be processed, which is the first group in the portion of A_{K-1} on the same row, is processed according to the method of Metaxas. The motivation for doing so would have been that the first pixel of the first group in A_{K-1} cannot be processed until all of the pixels from which said pixel depends have been processed (column 4, lines 18-20 of Metaxas), which includes the last pixel of the last group in A_K. Thus, processing the set of groups in A_K in figure 5 of Metaxas in parallel (divided in accordance figure 5 of Nguyen) will speed up the overall error diffusion processing. Since the set of pixels in A_{K-1} must wait for the last pixel in A_K, if all the pixels for one row of A_K are processed faster, then the processing of A_{K-1} will occur sooner. Thus, while the processing of A_K may cause a slight loss of accuracy owing to the fact that the error between the parallel processed groups (according to Nguyen) of a single row of A_K cannot be diffused between each other, this is greatly outweighed by the tremendous increase in speed. The combined system of Nguyen and Metaxas would be faster than the system of Metaxas alone, owing to the increased parallelism, and more accurate than the system of Nguyen alone, owing to the propagation of error diffusion between areas such as A_K and A_{K-1}. Therefore, it would have been obvious to combine Metaxas with Nguyen to obtain the invention as specified in claim 1.

5. Claims 2-11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nguyen (US Patent 5,892,851) in view of Metaxas (US Patent 6,307,978 B1) and Shiau (US Patent 5,880,857).

Regarding claim 2: Nguyen discloses dividing the error word for each pixel in the first group (figure 5(100) of Nguyen) into a first and second portion (column 3, lines 21-25 of Nguyen). The error word is diffused to other pixels using Floyd-Steinberg error diffusion (column 3, lines 21-25 of Nguyen), which diffuses the error word in portions (column 4, lines 27-32 of Nguyen). The process of error diffusion adds said first and second error words to image data for a first (figure 3(360) of Nguyen) and

second pixel (figure 3(370) of Nguyen) in the next row of pixels (figure 3 and column 3, lines 21-25 of Nguyen). As defined in the art, error diffusion requires that the weighted, diffused errors be added to the appropriate pixels in order to propagate the thresholding error for each pixel.

Nguyen in view of Metaxas does not disclose expressly generating a pseudo-random number; subtracting said pseudo-random number from said first portion to produce a first modified error word; and adding said pseudo-random number to said second portion to produce a second modified error word.

Shiau discloses:

- generating a pseudo-random number (column 5, lines 15-18 of Shiau).
- adding said pseudo-random number to image values (column 5, lines 29-32 of Shiau). The pseudo-random number can be positive or negative (column 5, lines 17-18 of Shiau). The addition of a negative pseudo-random number is the same as the subtraction of a positive pseudo-random number of the same magnitude.

Nguyen in view of Metaxas is combinable with Shiau because they are from the same field of endeavor, namely error diffusion of image data. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to subtract a pseudo-random number from said first portion, thus producing a first modified error word; and add said pseudo-random number to said second portion, thus producing a second modified error word. If said pseudo-random number is subtracted from said first portion, said pseudo-random number would need to be added to said second portion since, as is well known in the art, the total weights from an error diffusion filter need to add up to about 1, but no more than 1, in order to maintain numerical stability. The motivation for doing so would have been to defeat visual artifacts of a regular and deterministic nature (column 1, line 66 to column 2, line 1 of Shiau). Therefore, it would have been obvious to combine Shiau with Nguyen in view of Metaxas to obtain the invention as specified in claim 2.

Regarding claim 3: Nguyen discloses that said first modified error word is added to image pixel data for a pixel (figure 3(360) of Nguyen) directly below the pixel (figure 3 (310) of Nguyen) generating the error signal (column 3, lines 21-25 of Nguyen). The application of error diffusion (column 3, lines 21-25 of Nguyen) implies that a weighted error word, such as said first modified error word, is added to a corresponding pixel since, as is well known in the art, this is the basic process of error diffusion.

Regarding claim 4: Nguyen discloses that said second modified error word is added to image pixel data for a pixel (figure 3(370) of Nguyen) directly below and to the right of the pixel (figure 3(310) of Nguyen) generating the error signal (column 3, lines 21-25 of Nguyen).

Regarding claim 5: Nguyen discloses dividing the error word for each pixel in the second group (figure 5(500) of Nguyen) into a first (figure 6(620) of Nguyen) and second portion (figure 6(610) of Nguyen) (column 4, lines 4-5 and lines 27-32 of Nguyen). The error word is diffused to other pixels using a modified Floyd-Steinberg error diffusion (column 4, lines 27-29 of Nguyen), which diffuses the error word in portions (column 4, lines 27-32 of Nguyen). For said second group, the error filter is modified from what is shown in figure 3 to redistribute the error diffusion that would normally go from figure 3(310) to figure 3(330) of Nguyen (column 3, lines 59-62 of Nguyen). The process of error diffusion adds said first error word to image data for a pixel (figure 3(360) of Nguyen) in the next row of pixels (figure 3 and column 3, lines 21-25 of Nguyen). Since each segment of a row is processed in parallel by rows (column 3, lines 55-59 of Nguyen), said second error word is added to image data for a pixel (figure 3(370) of Nguyen) in said group of pixels to be processed next (figure 5 and column 3, lines 21-25 of Nguyen). As can be seen in figure 5 of Nguyen, the pixel to which said second error word is added (figure 3(370) of Nguyen) is in the segment which is below the segment that is the immediate right of the last pixel (figure 3 (310) of Nguyen), and is thus in said group of pixels to be processed next.

Nguyen in view of Metaxas does not disclose expressly generating a pseudo-random number; subtracting said pseudo-random number from said first portion to produce a first modified error word; and adding said pseudo-random number to said second portion to produce a second modified error word.

Shiau discloses:

- generating a pseudo-random number (column 5, lines 15-18 of Shiau).
- adding said pseudo-random number to image values (column 5, lines 29-32 of Shiau). The pseudo-random number can be positive or negative (column 5, lines 17-18 of Shiau). The addition of a negative pseudo-random number is the same as the subtraction of a positive pseudo-random number of the same magnitude.

Nguyen in view of Metaxas is combinable with Shiau because they are from the same field of endeavor, namely error diffusion of image data. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to subtract a pseudo-random number from said first portion, thus producing a first modified error word; and add said pseudo-random number to said second portion, thus producing a second modified error word. If said pseudo-random number is subtracted from said first portion, said pseudo-random number would need to be added to said second portion since, as is well known in the art, the total weights from an error diffusion filter need to add up to about 1, but no more than 1, in order to maintain numerical stability. The motivation for doing so would have been to defeat visual artifacts of a regular and deterministic nature (column 1, line 66 to column 2, line 1 of Shiau).

Therefore, it would have been obvious to combine Shiau with Nguyen in view of Metaxas to obtain the invention as specified in claim 5.

Regarding claim 6: The arguments regarding claim 5 are incorporated herein. As stated, the pseudo-random number can be positive or negative (column 5, lines 17-18 of Shiau); and the addition of a negative pseudo-random number is the same as the subtraction of a positive pseudo-random number of the same magnitude. Therefore, adding said pseudo random number to said first portion, as stated in claim 6, performs the same operations as adding a negative pseudo random number to said first portion, which is the subtraction stated in claim 5. Likewise, adding a negative pseudo random number, which is the subtraction stated in claim 6, to said second portion performs the same operations as adding a pseudo random number to said second portion, as stated in claim 5. Furthermore, if said pseudo-random number is added to said first portion, said pseudo-random number would need to be subtracted from said second portion since, as is well known in the art, the total weights from an error diffusion filter need to add up to about 1, but no more than 1, in order to maintain numerical stability.

Regarding claim 7: Nguyen discloses dividing the error word for each pixel in the first group (figure 5(100) of Nguyen) into a first and second portion (column 3, lines 21-25 of Nguyen). The error word is diffused to other pixels using Floyd-Steinberg error diffusion (column 3, lines 21-25 of Nguyen), which diffuses the error word in portions (column 4, lines 27-32 of Nguyen). The process of error diffusion adds said first and second error words to image data for a first (figure 3(360) of Nguyen) and second pixel (figure 3(370) of Nguyen) in the next row of pixels (figure 3 and column 3, lines 21-25 of Nguyen).

Nguyen in view of Metaxas does not disclose expressly generating a first and second pseudo-random number; adding said first pseudo-random number to said first portion to produce a first modified error word; and adding said second pseudo-random number to said second portion to produce a second modified error word.

Shiau discloses:

- generating a plurality of pseudo-random numbers (column 5, lines 15-18 of Shiau).
- adding said pseudo-random numbers to image values (column 5, lines 29-32 of Shiau).

Nguyen in view of Metaxas is combinable with Shiau because they are from the same field of endeavor, namely error diffusion of image data. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to add the first of a plurality of pseudo-random numbers to said first portion, thus producing a first modified error word; and add the second of a plurality of pseudo-random numbers to said second portion, thus producing a second modified error word. The motivation for doing

so would have been to defeat visual artifacts of a regular and deterministic nature (column 1, line 66 to column 2, line 1 of Shiau). Therefore, it would have been obvious to combine Shiau with Nguyen in view of Metaxas to obtain the invention as specified in claim 7.

Regarding claim 8: Nguyen discloses dividing the error word for each pixel in the second group (figure 5(500) of Nguyen) into a first (figure 6(620) of Nguyen) and second portion (figure 6(610) of Nguyen) (column 4, lines 4-5 and lines 27-32 of Nguyen). The error word is diffused to other pixels using a modified Floyd-Steinberg error diffusion (column 4, lines 27-29 of Nguyen), which diffuses the error word in portions (column 4, lines 27-32 of Nguyen). For said second group, the error filter is modified from what is shown in figure 3 to redistribute the error diffusion that would normally go from figure 3(310) to figure 3(330) of Nguyen (column 3, lines 59-62 of Nguyen). The process of error diffusion adds said first error word to image data for a pixel (figure 3(360) of Nguyen) in the next row of pixels (figure 3 and column 3, lines 21-25 of Nguyen). Since each segment of a row is processed in parallel by rows (column 3, lines 55-59 of Nguyen), said second error word is added to image data for a pixel (figure 3(370) of Nguyen) in said group of pixels to be processed next (figure 5 and column 3, lines 21-25 of Nguyen). As can be seen in figure 5 of Nguyen, the pixel to which said second error word is added (figure 3(370) of Nguyen) is in the segment which is below the segment to the immediate right of the last pixel (figure 3(310) of Nguyen), and is thus in said group of pixels to be processed next.

Nguyen in view of Metaxas does not disclose expressly generating a first and second pseudo-random number; adding said first pseudo-random number to said first portion to produce a first modified error word; and adding said second pseudo-random number to said second portion to produce a second modified error word.

Shiau discloses:

- generating a plurality of pseudo-random numbers (column 5, lines 15-18 of Shiau).
- adding said pseudo-random numbers to image values (column 5, lines 29-32 of Shiau).

Nguyen in view of Metaxas is combinable with Shiau because they are from the same field of endeavor, namely error diffusion of image data. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to add the first of a plurality of pseudo-random numbers to said first portion, thus producing a first modified error word; and add the second of a plurality of pseudo-random numbers to said second portion, thus producing a second modified error word. The motivation for doing so would have been to defeat visual artifacts of a regular and deterministic nature (column 1, line 66 to column 2, line 1 of Shiau). Therefore, it would have been obvious to combine Shiau with Nguyen in view of Metaxas to obtain the invention as specified in claim 8.

Regarding claim 9: The arguments regarding claim 7 are incorporated herein. As stated, the pseudo-random number can be positive or negative (column 5, lines 17-18 of Shiau); and the addition of a negative pseudo-random number is the same as the subtraction of a positive pseudo-random number of the same magnitude. Therefore, adding a negative second pseudo random number, which is the subtraction stated in claim 9, to said second portion performs the same operations as adding a second pseudo random number to said second portion, as stated in claim 7. Furthermore, if both the first pseudo-random number and second pseudo-random number are positive and the first pseudo-random number is added to said first portion, then said second pseudo-random number should be subtracted from said second portion. As is well known in the art, the total weights from an error diffusion filter need to add up to about 1, but no more than 1, in order to maintain numerical stability. Subtracting the second pseudo-random number from said second portion will help achieve numerical stability.

Regarding claim 10: The arguments regarding claim 8 are incorporated herein. As stated, the pseudo-random number can be positive or negative (column 5, lines 17-18 of Shiau); and the addition of a negative pseudo-random number is the same as the subtraction of a positive pseudo-random number of the same magnitude. Therefore, adding a negative second pseudo random number, which is the subtraction stated in claim 10, to said second portion performs the same operations as adding a second pseudo random number to said second portion, as stated in claim 8. Furthermore, if both the first pseudo-random number and second pseudo-random number are positive and the first pseudo-random number is added to said first portion, then said second pseudo-random number should be subtracted from said second portion. As is well known in the art, the total weights from an error diffusion filter need to add up to about 1, but no more than 1, in order to maintain numerical stability. Subtracting the second pseudo-random number from said second portion will help achieve numerical stability.

Regarding claim 11: The arguments regarding claim 8 are incorporated herein. As stated, the pseudo-random number can be positive or negative (column 5, lines 17-18 of Shiau); and the addition of a negative pseudo-random number is the same as the subtraction of a positive pseudo-random number of the same magnitude. Therefore, adding a negative first pseudo random number to said first portion, which is the subtraction stated in claim 11, performs the same operations as adding a first pseudo random number to said first portion, as stated in claim 8. Furthermore, if both the first pseudo-random number and second pseudo-random number are positive and the first pseudo-random number is subtracted from said first portion, then said second pseudo-random number should be added to said second portion. As is well known in the art, the total weights from an error diffusion filter need to add up to about 1, but no

more than 1, in order to maintain numerical stability. Adding the second pseudo-random number to said second portion will help achieve numerical stability.

6. Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nguyen (US Patent 5,892,851) in view of Metaxas (US Patent 6,307,978 B1) and Delabastita (US Patent 6,118,513).

Regarding claim 12: Nguyen discloses a display system (figure 2 of Nguyen) comprising a controller (figure 2(200) of Nguyen) for receiving and processing pixilated image data (column 3, lines 5-10 of Nguyen). Said controller performs the method of claim 1, the arguments of which are incorporated herein.

Nguyen does not disclose expressly that said group of pixels to be processed next, which are abutted by said last pixel, are in said row of pixels; a light source for generating a beam of light along a first light path; and a light modulator for selectively modulating light along said first light path in response to image data signals from said controller.

Metaxas discloses a group of pixels to be processed next which are abutted by the last pixel of the group of pixels that are being processed (figure 3; figure 5; and column 4, lines 48-55 of Metaxas). Error diffusion processing is performed in a diagonal manner (figure 5 and column 4, lines 48-55 of Metaxas). Furthermore, a pixel is only processed after all of the pixels from which said pixel depends have been processed. Thus (referring to figure 5 of Metaxas), the first pixel of the first row of A_{K-1} is processed only after the last pixel of the first row of A_K is processed. Thus, the last pixel of the first group of pixels to be processed abuts the group of pixels to be processed next in said row of pixel.

Nguyen and Metaxas are combinable because they are from the same field of endeavor, namely parallel error diffusion. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to combine the parallel processing method taught by Nguyen with the parallel processing method taught by Metaxas. Thus combined, the individual area (such as A_K in figure 5 of Metaxas) would be processed according to the method of Nguyen while the overall image would be processed according to the method of Metaxas. Therefore, the length "d" in figure 5 of Metaxas would be broken into two or more sections to be processed in parallel, such as shown in figure 5 of Nguyen. When the last pixel of A_K in figure 5 of Metaxas is processed, the next group to be processed, which is the first group in the portion of A_{K-1} on the same row, is processed according to the method of Metaxas. The motivation for doing so would have been that the first pixel of the first group in A_{K-1} cannot be processed until all of the pixels from which said pixel depends have been processed (column 4, lines 18-20 of Metaxas), which includes the last pixel of the last group in A_K. Thus, processing the set of groups in A_K in figure 5 of

Metaxas in parallel (divided in accordance figure 5 of Nguyen) will speed up the overall error diffusion processing. Since the set of pixels in A_{K-1} must wait for the last pixel in A_K, if all the pixels for one row of A_K are processed faster, then the processing of A_{K-1} will occur sooner. Thus, while the processing of A_K may cause a slight loss of accuracy owing to the fact that the error between the parallel processed groups (according to Nguyen) of a single row of A_K cannot be diffused between each other, this is greatly outweighed by the tremendous increase in speed. The combined system of Nguyen and Metaxas would be faster than the system of Metaxas alone, owing to the increased parallelism, and more accurate than the system of Nguyen alone, owing to the propagation of error diffusion between areas such as A_K and A_{K-1}. Therefore, it would have been obvious to combine Metaxas with Nguyen.

Nguyen in view of Metaxas does not disclose expressly a light source for generating a beam of light along a first light path; and a light modulator for selectively modulating light along said first light path in response to image data signals from said controller.

Delabastita discloses a light source (figure 1(3) of Delabastita) for generating a beam of light along a first light path (column 3, lines 45-49 of Delabastita); and a light modulator (figure 1(9) of Delabastita) for selectively modulating light along said first light path in response to image data signals from said controller (column 3, lines 49-55 of Delabastita). The hardware (figure 1(9) of Delabastita) controls the rasterization of the image based on the received density values (column 3, lines 49-55 of Delabastita). The density values are processed using error diffusion (column 3, line 67 to column 4, line 4 of Delabastita) and compared with a threshold, which results in outputting either a 1 or a 0 (column 4, lines 4, lines 4-12 of Delabastita).

Nguyen in view of Metaxas is combinable with Delabastita because they are from the same field of endeavor, namely image data processing. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to use the device of Delabastita to output the halftone data determined by the system of Nguyen. The motivation for doing so would have been to be able to copy the halftoned image data onto light-sensitive materials (column 4, lines 45-50 of Delabastita). Therefore, it would have been obvious to combine Delabastita with Nguyen in view of Metaxas to obtain the invention as specified in claim 12.

7. Claims 13-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nguyen (US Patent 5,892,851) in view of Metaxas (US Patent 6,307,978 B1), Delabastita (US Patent 6,118,513), and Shiau (US Patent 5,880,857).

Regarding claim 13: Nguyen discloses that said controller (figure 2(200) of Nguyen) divides the error word for each pixel in the first group (figure 5(100) of Nguyen) into a first and second portion (column 3, lines 21-25 of Nguyen). The error word is diffused to other pixels using Floyd-Steinberg error diffusion (column 3, lines 21-25 of Nguyen), which diffuses the error word in portions (column 4, lines 27-32 of Nguyen). The process of error diffusion adds said first and second error words to image data for a first (figure 3(360) of Nguyen) and second pixel (figure 3(370) of Nguyen) in the next row of pixels (figure 3 and column 3, lines 21-25 of Nguyen).

Nguyen in view of Metaxas and Delabastita does not disclose expressly generating a pseudo-random number; subtracting said pseudo-random number from said first portion to produce a first modified error word; and adding said pseudo-random number to said second portion to produce a second modified error word.

Shiau discloses:

- generating a pseudo-random number (column 5, lines 15-18 of Shiau).
- adding said pseudo-random number to image values (column 5, lines 29-32 of Shiau). The pseudo-random number can be positive or negative (column 5, lines 17-18 of Shiau). The addition of a negative pseudo-random number is the same as the subtraction of a positive pseudo-random number of the same magnitude.

Nguyen in view of Metaxas and Delabastita is combinable with Shiau because they are from the same field of endeavor, namely image data processing. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to have said controller subtract a pseudo-random number from said first portion, thus producing a first modified error word; and add said pseudo-random number to said second portion, thus producing a second modified error word. If said pseudo-random number is subtracted from said first portion, said pseudo-random number would need to be added to said second portion since, as is well known in the art, the total weights from an error diffusion filter need to add up to about 1, but no more than 1, in order to maintain numerical stability. The motivation for doing so would have been to defeat visual artifacts of a regular and deterministic nature (column 1, line 66 to column 2, line 1 of Shiau). Therefore, it would have been obvious to combine Shiau with Nguyen in view of Metaxas and Delabastita to obtain the invention as specified in claim 13.

Regarding claim 14: Nguyen discloses that said controller (figure 2(200) of Nguyen) divides the error word for each pixel in the second group (figure 5(500) of Nguyen) into a first (figure 6(620) of Nguyen) and second portion (figure 6(610) of Nguyen) (column 4, lines 4-5 and lines 27-32 of Nguyen). The error word is diffused to other pixels using a modified Floyd-Steinberg error diffusion (column 4, lines 27-29 of Nguyen), which diffuses the error word in portions (column 4, lines 27-32 of Nguyen). For said second group, the error filter is modified from what is shown in figure 3 to redistribute the error diffusion that would normally go from figure 3(310) to figure 3(330) of Nguyen (column 3, lines 59-62 of Nguyen). The process of error diffusion adds said first error word to image data for a pixel (figure 3(360) of Nguyen) in the next row of pixels (figure 3 and column 3, lines 21-25 of Nguyen). Since each segment of a row is processed in parallel by rows (column 3, lines 55-59 of Nguyen), said second error word is added to image data for a pixel (figure 3(370) of Nguyen) in said group of pixels to be processed next (figure 5 and column 3, lines 21-25 of Nguyen). As can be seen in figure 5 of Nguyen, the pixel to which said second error word is added (figure 3(370) of Nguyen) is in the segment which is below the segment to the immediate right of the last pixel (figure 3(310) of Nguyen), and is thus in said group of pixels to be processed next.

Nguyen in view of Metaxas and Delabastita does not disclose expressly generating a pseudo-random number; subtracting said pseudo-random number from said first portion to produce a first modified error word; and adding said pseudo-random number to said second portion to produce a second modified error word.

Shiau discloses:

- generating a pseudo-random number (column 5, lines 15-18 of Shiau).
- adding said pseudo-random number to image values (column 5, lines 29-32 of Shiau). The pseudo-random number can be positive or negative (column 5, lines 17-18 of Shiau). The addition of a negative pseudo-random number is the same as the subtraction of a positive pseudo-random number of the same magnitude.

Nguyen in view of Metaxas and Delabastita is combinable with Shiau because they are from the same field of endeavor, namely image data processing. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to have said controller subtract a pseudo-random number from said first portion, thus producing a first modified error word; and add said pseudo-random number to said second portion, thus producing a second modified error word. If said pseudo-random number is subtracted from said first portion, said pseudo-random number would need to be added to said second portion since, as is well known in the art, the total weights from an error diffusion filter need to add up to

about 1, but no more than 1, in order to maintain numerical stability. The motivation for doing so would have been to defeat visual artifacts of a regular and deterministic nature (column 1, line 66 to column 2, line 1 of Shiau). Therefore, it would have been obvious to combine Shiau with Nguyen in view of Metaxas and Delabastita to obtain the invention as specified in claim 14.

Regarding claim 15: The arguments regarding claim 14 are incorporated herein. As stated, the pseudo-random number can be positive or negative (column 5, lines 17-18 of Shiau); and the addition of a negative pseudo-random number is the same as the subtraction of a positive pseudo-random number of the same magnitude. Therefore, adding said pseudo random number to said first portion, as stated in claim 15, performs the same operations as adding a negative pseudo random number to said first portion, which is the subtraction stated in claim 14. Likewise, adding a negative pseudo random number, which is the subtraction stated in claim 15, to said second portion performs the same operations as adding a pseudo random number to said second portion, as stated in claim 14. Furthermore, if said pseudo-random number is added to said first portion, said pseudo-random number would need to be subtracted from said second portion since, as is well known in the art, the total weights from an error diffusion filter need to add up to about 1, but no more than 1, in order to maintain numerical stability.

Regarding claim 16: <u>Nguyen discloses</u> that said controller (figure 2(200) of Nguyen) divides the error word for each pixel in the first group (figure 5(100) of Nguyen) into a first and second portion (column 3, lines 21-25 of Nguyen). The error word is diffused to other pixels using Floyd-Steinberg error diffusion (column 3, lines 21-25 of Nguyen), which diffuses the error word in portions (column 4, lines 27-32 of Nguyen). The process of error diffusion adds said first and second error words to image data for a first (figure 3(360) of Nguyen) and second pixel (figure 3(370) of Nguyen) in the next row of pixels (figure 3 and column 3, lines 21-25 of Nguyen).

Nguyen in view of Metaxas and Delabastita does not disclose expressly generating a first and second pseudo-random number; adding said first pseudo-random number to said first portion to produce a first modified error word; and adding said second pseudo-random number to said second portion to produce a second modified error word.

<u>Shiau discloses:</u>

- generating a plurality of pseudo-random numbers (column 5, lines 15-18 of Shiau).
- adding said pseudo-random numbers to image values (column 5, lines 29-32 of Shiau).

Nguyen in view of Metaxas and Delabastita is combinable with Shiau because they are from the same field of endeavor, namely image data processing. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to use said controller to add the first of a plurality of

pseudo-random numbers to said first portion, thus producing a first modified error word; and add the second of a plurality of pseudo-random numbers to said second portion, thus producing a second modified error word. The motivation for doing so would have been to defeat visual artifacts of a regular and deterministic nature (column 1, line 66 to column 2, line 1 of Shiau). Therefore, it would have been obvious to combine Shiau with Nguyen in view of Metaxas and Delabastita to obtain the invention as specified in claim 16.

Regarding claim 17: Nguyen discloses that said controller (figure 2(200) of Nguyen) divides the error word for each pixel in the second group (figure 5(500) of Nguyen) into a first (figure 6(620) of Nguyen) and second portion (figure 6(610) of Nguyen) (column 4, lines 4-5 and lines 27-32 of Nguyen). The error word is diffused to other pixels using a modified Floyd-Steinberg error diffusion (column 4, lines 27-29 of Nguyen), which diffuses the error word in portions (column 4, lines 27-32 of Nguyen). For said second group, the error filter is modified from what is shown in figure 3 to redistribute the error diffusion that would normally go from figure 3(310) to figure 3(330) of Nguyen (column 3, lines 59-62 of Nguyen). The process of error diffusion adds said first error word to image data for a pixel (figure 3(360) of Nguyen) in the next row of pixels (figure 3 and column 3, lines 21-25 of Nguyen). Since each segment of a row is processed in parallel by rows (column 3, lines 55-59 of Nguyen), said second error word is added to image data for a pixel (figure 3(370) of Nguyen) in said group of pixels to be processed next (figure 5 and column 3, lines 21-25 of Nguyen). As can be seen in figure 5 of Nguyen, the pixel to which said second error word is added (figure 3(370) of Nguyen) is in the segment which is below the segment to the immediate right of the last pixel (figure 3(310) of Nguyen), and is thus in said group of pixels to be processed next.

Nguyen in view of Metaxas and Delabastita does not disclose expressly generating a first and second pseudo-random number; adding said first pseudo-random number to said first portion to produce a first modified error word; and adding said second pseudo-random number to said second portion to produce a second modified error word.

Shiau discloses:

- generating a plurality of pseudo-random numbers (column 5, lines 15-18 of Shiau).
- adding said pseudo-random numbers to image values (column 5, lines 29-32 of Shiau).

Nguyen in view of Metaxas and Delabastita is combinable with Shiau because they are from the same field of endeavor, namely image data processing. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to have said controller add the first of a plurality of pseudo-random numbers to said first portion, thus producing a first modified error word; and add the second of a

plurality of pseudo-random numbers to said second portion, thus producing a second modified error word. The motivation for doing so would have been to defeat visual artifacts of a regular and deterministic nature (column 1, line 66 to column 2, line 1 of Shiau). Therefore, it would have been obvious to combine Shiau with Nguyen in view of Metaxas and Delabastita to obtain the invention as specified in claim 17.

Regarding claim 18: The arguments regarding claim 16 are incorporated herein. As stated, the pseudo-random number can be positive or negative (column 5, lines 17-18 of Shiau); and the addition of a negative pseudo-random number is the same as the subtraction of a positive pseudo-random number of the same magnitude. Therefore, adding a negative second pseudo random number, which is the subtraction stated in claim 18, to said second portion performs the same operations as adding a second pseudo random number to said second portion, as stated in claim 16. Furthermore, if both the first pseudo-random number and second pseudo-random number are positive and the first pseudo-random number is added to said first portion, then said second pseudo-random number should be subtracted from said second portion. As is well known in the art, the total weights from an error diffusion filter need to add up to about 1, but no more than 1, in order to maintain numerical stability. Subtracting the second pseudo-random number from said second portion will help achieve numerical stability.

Regarding claim 19: The arguments regarding claim 17 are incorporated herein. As stated, the pseudo-random number can be positive or negative (column 5, lines 17-18 of Shiau); and the addition of a negative pseudo-random number is the same as the subtraction of a positive pseudo-random number of the same magnitude. Therefore, adding a negative second pseudo random number, which is the subtraction stated in claim 19, to said second portion performs the same operations as adding a second pseudo random number to said second portion, as stated in claim 17. Furthermore, if both the first pseudo-random number and second pseudo-random number are positive and the first pseudo-random number is added to said first portion, then said second pseudo-random number should be subtracted from said second portion. As is well known in the art, the total weights from an error diffusion filter need to add up to about 1, but no more than 1, in order to maintain numerical stability. Subtracting the second pseudo-random number from said second portion will help achieve numerical stability.

Regarding claim 20: The arguments regarding claim 17 are incorporated herein. As stated, the pseudo-random number can be positive or negative (column 5, lines 17-18 of Shiau); and the addition of a negative pseudo-random number is the same as the subtraction of a positive pseudo-random number of the same magnitude. Therefore, adding a negative first pseudo random number to said first portion, which is the subtraction stated in claim 20, performs the same operations as adding a first pseudo random

number to said first portion, as stated in claim 17. Furthermore, if both the first pseudo-random number and second pseudo-random number are positive and the first pseudo-random number is subtracted from said first portion, then said second pseudo-random number should be added to said second portion. As is well known in the art, the total weights from an error diffusion filter need to add up to about 1, but no more than 1, in order to maintain numerical stability. Adding the second pseudo-random number to said second portion will help achieve numerical stability.

8. Claim 21 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nguyen (US Patent 5,892,851) in view of Metaxas (US Patent 6,307,978 B1) and Yamada (US Patent 6,556,214 B1).

Regarding claim 21: Nguyen discloses a method of performing error diffusion, the method comprising the steps of:

- simultaneously processing image data for at least two pixels (figure 5(100,500(associated pixels)) of Nguyen) in a row of pixels (figure 5(510) of Nguyen), said at least two pixels comprising a first group of pixels (figure 5(100(associated pixels)) of Nguyen) and a last pixel (figure 5(500 (associated pixels)) of Nguyen) (column 4, lines 1-7 of Nguyen). A four-weight filter (figure 5(100) of Nguyen) is applied to all but the last one of the pixels in a segment of the image row (column 4, lines 6-7 of Nguyen) and a three-weight filter (figure 5(500) of Nguyen) is applied to the last pixel in said segment (column 4, lines 4-5 of Nguyen). Each segment of the image row is computed in parallel (column 3, lines 55-59 of Nguyen). The image rows (figure 5(510) of Nguyen) are processed one image row at a time (column 3, lines 18-19 of Nguyen), as demonstrated in the example embodiment in column 5, lines 35-40 of Nguyen. When a pixel in a segment is processed according to the filter labeled **100** in figure 5 of Nguyen, corresponding pixels in the other segments are also being processed according to the filter labeled **100** in figure 5 of Nguyen. When the end of each segment is reached, then each processor is processing a pixel in each segment corresponding to the cut filter labeled **500** in figure 5 of Nguyen. Furthermore, since the next image row is to be processed next, then the last pixel abuts the group of pixels to be processed next.
- reducing the precision of said image data to produce a modified image data word (column 3, lines 7-10 of Nguyen) and an error word for each pixel (column 3, lines 5-7 of Nguyen). Since the image is originally a continuous-tone image and is transformed into a halftone image (column 3, lines 7-10 of Nguyen), then the precision of said modified image data is reduced since a halftone image, by definition, comprises only one bit per pixel and a continuous-tone image, by definition,

comprises more than one bit per pixel. Error diffusion processing of image data (column 3, lines 5-7 of Nguyen), by definition, produces an error word for each pixel based on the difference between the halftone value and the original continuous-tone value, and then diffuses said error to other pixels.

- propagating portions of said error word for each pixel in said first group to pixels in said next row of pixels (figure 5(100(associated pixels)); column 3, lines 21-25; and column 4, lines 6-7 of Nguyen). The four-weight filter (figure 5(100) of Nguyen) is used for all of the pixels of the segment except for the last one (figure 5 and column 4, lines 6-7 of Nguyen). A portion of said error word for each pixel using said four-weight pixel (first group) is propagated to two pixels (figure 3(360,370) of Nguyen) in the next row of pixels, as demonstrated by the error diffusion arrows of figure 5(100) of Nguyen and the error diffusion propagation shown in figure 3 of Nguyen in which the error of pixel **100** is propagated to pixels **360** and **370**, which are clearly in the next row to be processed (column 3, lines 21-25 of Nguyen).
- propagating a first portion of said error word for said last pixel to at least one pixel in said next row of pixels and a second portion of said error word for said last pixel to at least one pixel in said group of pixels to be processed next (figure 5(500 (associated pixels)) and column 4, lines 1-5 of Nguyen). Figure 6 of Nguyen shows the three-weight filter (column 2, lines 53-55 of Nguyen) used for the last pixel of each segment (column 4, lines 4-5 of Nguyen). Error is propagated from said last pixel into the next row using said three-weight filter (column 4, lines 1-5 of Nguyen). As can clearly be seen from figure 5 of Nguyen, the error portions corresponding to figure 6(630) and figure 6(620) of Nguyen (first portion) are each propagated to a pixel in said next row of pixels and the error portion corresponding to figure 6(610) of Nguyen (second portion) is propagated into the first pixel of the segment below and to the right of said last pixel. The segment below and to the right of said last pixel is to be processed next since all segments of a row are processed in parallel (column 3, lines 55-59 of Nguyen).
- outputting a data signal for causing a display corresponding to said pixels in said next row of pixels at least in part in response to said portions of said error (figure 2(280) and column 3, lines 5-10 of Nguyen – *results of method output to an output device (display)*).
- outputting a data signal for causing a display corresponding to said at least one pixel in said group of pixels to be processed next at least in part in response to said second portion of said error word (figure 2(280) and column 3, lines 5-10 of Nguyen – *results of method output to an output device (display)*).

Nguyen does not disclose expressly that said group of pixels to be processed next, which are abutted by said last pixel, are in said row of pixels; and that portions of said error word for each pixel in said first group is propagated *only* to pixels in a next row of pixels.

Metaxas discloses a group of pixels to be processed next which are abutted by the last pixel of the group of pixels that are being processed (figure 3; figure 5; and column 4, lines 48-55 of Metaxas). Error diffusion processing is performed in a diagonal manner (figure 5 and column 4, lines 48-55 of Metaxas). Furthermore, a pixel is only processed after all of the pixels from which said pixel depends have been processed. Thus (referring to figure 5 of Metaxas), the first pixel of the first row of A_{K-1} is processed only after the last pixel of the first row of A_K is processed. Thus, the last pixel of the first group of pixels to be processed abuts the group of pixels to be processed next in said row of pixel.

Nguyen and Metaxas are combinable because they are from the same field of endeavor, namely parallel error diffusion. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to combine the parallel processing method taught by Nguyen with the parallel processing method taught by Metaxas. Thus combined, the individual area (such as A_K in figure 5 of Metaxas) would be processed according to the method of Nguyen while the overall image would be processed according to the method of Metaxas. Therefore, the length "d" in figure 5 of Metaxas would be broken into two or more sections to be processed in parallel, such as shown in figure 5 of Nguyen. When the last pixel of A_K in figure 5 of Metaxas is processed, the next group to be processed, which is the first group in the portion of A_{K-1} on the same row, is processed according to the method of Metaxas. The motivation for doing so would have been that the first pixel of the first group in A_{K-1} cannot be processed until all of the pixels from which said pixel depends have been processed (column 4, lines 18-20 of Metaxas), which includes the last pixel of the last group in A_K. Thus, processing the set of groups in A_K in figure 5 of Metaxas in parallel (divided in accordance figure 5 of Nguyen) will speed up the overall error diffusion processing. Since the set of pixels in A_{K-1} must wait for the last pixel in A_K, if all the pixels for one row of A_K are processed faster, then the processing of A_{K-1} will occur sooner. Thus, while the processing of A_K may cause a slight loss of accuracy owing to the fact that the error between the parallel processed groups (according to Nguyen) of a single row of A_K cannot be diffused between each other, this is greatly outweighed by the tremendous increase in speed. The combined system of Nguyen and Metaxas would be faster than the system of Metaxas alone, owing to the increased parallelism, and more accurate than the system of Nguyen alone, owing to the propagation of error diffusion between areas such as A_K and A_{K-1}. Therefore, it would have been obvious to combine Metaxas with Nguyen.

Nguyen in view of Metaxas does not disclose expressly that portions of said error word for each pixel in said first group is propagated *only* to pixels in a next row of pixels.

Yamada discloses propagating an error word for each pixel in a first group of pixels only to pixels in a next row of pixels (figures 7A-7B and column 13, lines 8-25 of Yamada).

Nguyen in view of Metaxas is combinable with Yamada because they are from the same field of endeavor, namely parallel error diffusion. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to propagate the error word portions only to pixels in the next row of pixels, as taught by Yamada. The motivation for doing so would have been to provide more time for computations if needed (column 2, line 57-65 of Yamada), or if the processor is fast, then the error diffusion processing can be performed faster since less time would be required. For the parallel processing system taught by Nguyen, this would provide for greater parallelism and speed of processing between pixel rows. Therefore, it would have been obvious to combine Yamada with Nguyen in view of Metaxas to obtain the invention as specified in claim 21.

9. Claim 22 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nguyen (US Patent 5,892,851) in view of Metaxas (US Patent 6,307,978 B1), Yamada (US Patent 6,556,214 B1), and Shiau (US Patent 5,880,857).

Regarding claim 22: Nguyen discloses dividing the error word for each pixel in the first group (figure 5(100) of Nguyen) into a first and a second portion (column 3, lines 21-25 of Nguyen). The error word is diffused to other pixels using Floyd-Steinberg error diffusion (column 3, lines 21-25 of Nguyen), which diffuses the error word in portions (column 4, lines 27-32 of Nguyen). The process of error diffusion adds said first and second error words to image data for a first (figure 3(360) of Nguyen) and second pixel (figure 3(370) of Nguyen) in the next row of pixels (figure 3 and column 3, lines 21-25 of Nguyen). As defined in the art, error diffusion requires that the weighted, diffused errors be added to the appropriate pixels in order to propagate the thresholding error for each pixel.

Nguyen in view of Metaxas does not disclose expressly generating a pseudo-random number; subtracting said pseudo-random number from said first portion to produce a first modified error word; adding said pseudo-random number to said second portion to produce a second modified error word; and adding said first and said second modified error words to image data in said next row of pixels.

Yamada discloses adding a first and a second portion of an error word to image data in the next row of pixels (figures 7A-7B and column 13, lines 8-25 of Yamada).

Nguyen in view of Metaxas is combinable with Yamada because they are from the same field of endeavor, namely parallel error diffusion. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to add the error word portions to the respective pixels in the next row of pixels, as taught by Yamada. The motivation for doing so would have been to provide more time for computations if needed (column 2, line 57-65 of Yamada), or if the processor is fast, then the error diffusion processing can be performed faster since less time would be required. For the parallel processing system taught by Nguyen, this would provide for greater parallelism and speed of processing between pixel rows. Therefore, it would have been obvious to combine Yamada with Nguyen in view of Metaxas.

Nguyen in view of Metaxas and Yamada does not disclose expressly generating a pseudo-random number; subtracting said pseudo-random number from said first portion to produce a first modified error word; adding said pseudo-random number to said second portion to produce a second modified error word; and that said first and said second portions of said error word added to the next row of pixels are specifically said first and said second modified error words.

Shiau discloses:

- generating a pseudo-random number (column 5, lines 15-18 of Shiau).
- adding said pseudo-random number to image values (column 5, lines 29-32 of Shiau). The pseudo-random number can be positive or negative (column 5, lines 17-18 of Shiau). The addition of a negative pseudo-random number is the same as the subtraction of a positive pseudo-random number of the same magnitude.

Nguyen in view of Metaxas and Yamada is combinable with Shiau because they are from the same field of endeavor, namely error diffusion of image data. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to subtract a pseudo-random number from said first portion, thus producing a first modified error word; and add said pseudo-random number to said second portion, thus producing a second modified error word. If said pseudo-random number is subtracted from said first portion, said pseudo-random number would need to be added to said second portion since, as is well known in the art, the total weights from an error diffusion filter need to add up to about 1, but no more than 1, in order to maintain numerical stability. Also, since the pseudo-random number is added or subtracted to the respective portion of the error word before error propagation, said first and said second portions of said error word added to the next row of pixels would therefore be said first and said second modified error words taught by Shiau. The motivation for doing so would have been to defeat visual artifacts of a regular and deterministic nature (column 1, line 66 to column 2, line 1 of Shiau). Therefore,

it would have been obvious to combine Shiau with Nguyen in view of Metaxas to obtain the invention as specified in claim 22.

Conclusion

10. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to James A. Thompson whose telephone number is 571-272-7441. The examiner can normally be reached on 8:30AM-5:00PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, David K. Moore can be reached on 571-272-7437. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

James A. Thompson
Examiner
Technology Division 2625

JAT
26 June 2007

David Moore

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